

## CLAIMS

1. A current switch comprising:  
a differential pair of transistors Q1 and Q2;  
a pair of cascode transistors Q<sub>A</sub> and Q<sub>B</sub> coupled to Q1 and Q2, respectively;  
and  
5 first means for maintaining said transistors Q<sub>A</sub> and Q<sub>B</sub> in an 'on' state regardless of the states of Q1 and Q2.
2. The invention of Claim 1 wherein said first means includes a first current source adapted to supply a first trickle current to said transistor Q<sub>A</sub>.
3. The invention of Claim 2 wherein said first means further includes a second current source adapted to supply a second trickle current to said transistor Q<sub>B</sub>.
4. The invention of Claim 3 wherein said first and second current sources are coupled to the emitters of Q<sub>A</sub> and Q<sub>B</sub>, respectively.
5. The invention of Claim 3 wherein said first and second trickle currents are approximately equal.
6. The invention of Claim 1 wherein the emitters of Q<sub>A</sub> and Q<sub>B</sub> are coupled to the collectors of Q1 and Q2, respectively.
7. The invention of Claim 1 wherein the collectors of Q<sub>A</sub> and Q<sub>B</sub> are coupled to first and second outputs, respectively.
8. The invention of Claim 1 wherein the bases of Q<sub>A</sub> and Q<sub>B</sub> are connected in common to a voltage source V<sub>REF4</sub>.

9. The invention of Claim 8 wherein said voltage source  $V_{REF4}$  has low impedance.

10. The invention of Claim 9 wherein said voltage source  $V_{REF4}$  includes a Schottky diode.

11. The invention of Claim 10 wherein said voltage source  $V_{REF4}$  further includes a current source coupled to said Schottky diode.

12. The invention of Claim 3 wherein said current switch further includes a third current source adapted to supply a third current to the common emitters of Q1 and Q2.

13. The invention of Claim 12 wherein said first and second trickle currents are significantly smaller than said third current.

14. The invention of Claim 12 wherein said current switch further includes second means for supplying complementary input signals  $B_n$  and  $-B_n$ .

15. The invention of Claim 14 wherein said transistors Q1 and Q2 are adapted to couple said third current to either the collector of Q1 or the collector of Q2 in response to said complementary input signals  $B_n$  and  $-B_n$ .

16. The invention of Claim 15 wherein the bases of Q1 and Q2 are coupled to said complementary input signals  $B_n$  and  $-B_n$ .

17. The invention of Claim 12 wherein said current switch further includes a transistor Q5 connected between said third current source and the common emitters of Q1 and Q2.

18. The invention of Claim 17 wherein the base of Q5 is coupled to a voltage supply  $V_{REF2}$ .

19. The invention of Claim 14 wherein said second means includes a driver circuit.

20. The invention of Claim 19 wherein said driver circuit includes a current switch comprising:

a fourth current source for supplying a fourth current;

5 a differential pair of transistors Q10 and Q11 adapted to couple said fourth current to either the collector of Q10 or the collector of Q11 in response to complementary input signals  $X_n$  and  $-X_n$ ;

a pair of cascode transistors Q14 and Q15 having emitters coupled to the collectors of Q10 and Q11, respectively; and

10 fifth and sixth current sources adapted to supply trickle currents to the emitters of Q14 and Q15, respectively, in order to maintain said transistors Q14 and Q15 in an 'on' state regardless of the states of Q10 and Q11.

21. The invention of Claim 20 wherein said driver circuit further includes two transistors Q12 and Q13 having bases coupled to the collectors of Q14 and Q15, respectively, collectors coupled to ground, and emitters coupled to outputs  $-B_n$  and  $B_n$ , respectively.

22. A current switch comprising:

a first current source for supplying a first current;

5 a differential pair of transistors Q1 and Q2 adapted to couple said first current to either the collector of Q1 or the collector of Q2 in response to complementary input signals  $B_n$  and  $-B_n$ ;

a pair of cascode transistors  $Q_A$  and  $Q_B$  having emitters coupled to the collectors of Q1 and Q2, respectively; and

second and third current sources adapted to supply first and second trickle currents to the emitters of  $Q_A$  and  $Q_B$ , respectively, in order to maintain said transistors  $Q_A$  and  $Q_B$  in an 'on' state regardless of the states of  $Q_1$  and  $Q_2$ .

23. A driver circuit comprising:  
a first current source for supplying a first current;  
a differential pair of transistors  $Q_{10}$  and  $Q_{11}$  adapted to couple said first current to either the collector of  $Q_{10}$  or the collector of  $Q_{11}$  in response to complementary input signals  $X_n$  and  $-X_n$ ;  
a pair of cascode transistors  $Q_{14}$  and  $Q_{15}$  having emitters coupled to the collectors of  $Q_{10}$  and  $Q_{11}$ , respectively;  
second and third current sources adapted to supply first and second trickle currents to the emitters of  $Q_{14}$  and  $Q_{15}$ , respectively, in order to maintain said transistors  $Q_{14}$  and  $Q_{15}$  in an 'on' state regardless of the states of  $Q_{10}$  and  $Q_{11}$ ; and  
two transistors  $Q_{12}$  and  $Q_{13}$  having bases coupled to the collectors of  $Q_{14}$  and  $Q_{15}$ , respectively, and emitters adapted to output voltages  $-B_n$  and  $B_n$ , respectively.

24. The invention of Claim 23 wherein the collectors of  $Q_{14}$  and  $Q_{15}$  are each connected to ground through a resistor  $R_s$ .

25. The invention of Claim 23 wherein the collectors of  $Q_{12}$  and  $Q_{13}$  are connected to ground.

26. The invention of Claim 23 wherein said driver circuit further includes fourth and fifth current sources coupled to the emitters of  $Q_{12}$  and  $Q_{13}$ , respectively.

27. The invention of Claim 23 wherein said first current and said first and second trickle currents are chosen to generate a desired output voltage swing at the emitters of  $Q_{12}$  and  $Q_{13}$ .

28. A digital to analog converter comprising:
- a first current summing bus;
  - a second current summing bus; and
  - a plurality of current switches, each switch including:
    - 5 a first current source for supplying a first current;
    - a differential pair of transistors Q1 and Q2 adapted to couple said first current to either the first current summing bus or the second current summing bus in response to complementary input signals  $B_n$  and  $-B_n$ ;
    - a pair of cascode transistors  $Q_A$  and  $Q_B$  having emitters coupled to the
    - 10 collectors of Q1 and Q2, respectively, and collectors coupled to said first and second current summing buses, respectively; and
    - second and third current sources adapted to supply first and second trickle currents to the emitters of  $Q_A$  and  $Q_B$ , respectively, in order to maintain said transistors  $Q_A$  and  $Q_B$  in an 'on' state regardless of the states of Q1 and Q2.
29. The invention of Claim 28 wherein the bases of  $Q_A$  and  $Q_B$  are connected in common to a voltage source  $V_{REF4}$ .
30. The invention of Claim 29 wherein said voltage source  $V_{REF4}$  has low impedance.
31. The invention of Claim 29 wherein said voltage source  $V_{REF4}$  includes a Schottky diode.
32. The invention of Claim 31 wherein said voltage source  $V_{REF4}$  further includes a current source coupled to said Schottky diode.
33. The invention of Claim 28 wherein each current switch further includes a transistor Q5 connected between said first current source and the common emitters of

Q1 and Q2.

34. The invention of Claim 33 wherein the base of Q5 is coupled to a voltage supply  $V_{REF2}$ .

35. The invention of Claim 28 wherein said first and second trickle currents are approximately equal.

36. The invention of Claim 28 wherein said first and second trickle currents are significantly smaller than said first current.

37. The invention of Claim 28 wherein each current switch further includes a driver circuit for supplying said complementary input signals  $B_n$  and  $-B_n$ .

38. The invention of Claim 37 wherein said driver circuit includes:

a fourth current source for supplying a fourth current;

a differential pair of transistors Q10 and Q11 adapted to couple said fourth current to either the collector of Q10 or the collector of Q11 in response to  
5 complementary input signals  $X_n$  and  $-X_n$ ;

a pair of cascode transistors Q14 and Q15 having emitters coupled to the collectors of Q10 and Q11, respectively;

fifth and sixth current sources adapted to supply third and fourth trickle currents to the emitters of Q14 and Q15, respectively, in order to maintain said  
10 transistors Q14 and Q15 in an 'on' state regardless of the states of Q10 and Q11; and

two transistors Q12 and Q13 having bases coupled to the collectors of Q14 and Q15, respectively, and emitters adapted to output voltages  $-B_n$  and  $B_n$ , respectively.

39. The invention of Claim 38 wherein said fourth current and said third and fourth trickle currents are chosen to generate a low output voltage swing at the

emitters of Q12 and Q13.

40. A method for increasing the speed of a current switch comprising a differential pair of transistors Q1 and Q2 including the steps of:

connecting a pair of cascode transistors  $Q_A$  and  $Q_B$  to the outputs of Q1 and Q2, respectively, and

5 supplying trickle currents to said transistors  $Q_A$  and  $Q_B$  in order to keep them in an 'on' state regardless of the states of Q1 and Q2.